THE WEATHER RESEARCH AND FORECAST MODEL VERSION 2: 2006 UPDATE

Jimy Dudhia
National Center for Atmospheric Research
Boulder, Colorado

1. INTRODUCTION

WRF Version 2.0 was released in May 2004, followed by minor bug-fix releases up to 2.0.3.1 in December 2004.

Version 2.1 was released in August 2005, followed by bug-fix releases 2.1.1 in November 2005, and 2.1.2 in January 2006.

Version 2.2 is currently under preparation for release in the summer of 2006.

Here we outline the current status and plans for the WRF model focusing on the shared physics and ARW dynamical core.

2. STATUS

The current release is Version 2.1.2. New capabilities since the version in the last workshop (2.0.3.1) include the new Thompson et al. (2004) microphysics scheme, an upper Rayleigh damping option for idealized cases, and moving nests. A GFS suite of physics was added for the NMM dynamical core, but has not yet been tested for the ARW core. This suite consists of the GFS PBL scheme, similar to the MRF PBL scheme, and the Simplified Arakawa-Schubert cumulus scheme, similar to MM5's Grell scheme.

A sea-surface temperature update capability was added, whereby new SST and vegetation fractions can be read in as the run progresses. This is useful in long-term simulations.

The NCEP suite of physics was upgraded for consistency with operational codes. The most significant change was probably the Betts-Miller-Janjic cumulus scheme that had an enthalpy check added, significantly reducing the area of convective rainfall.

Most other physics options had minor improvements or bug-fixes during the year. The Noah LSM use of emissivity was improved to reduce a night-time warm bias problem. In 2.1.1, the surface-layer scheme for the YSU and MRF PBL schemes had an important correction for roughness length over water where, due to an error, it was not accounting for windspeed to determine surface roughness length leading to an over-prediction of hurricane surface windspeeds, for example. The Charnock constant was also reduced to more conventional values in this same part of the code.

The nested boundaries had a relaxation zone added, like the coarse-mesh specified boundary condition, in order to prevent the generation of potential vorticity streamers on upwind nest boundaries.

In 2.1.2, the cumulus-scheme ice and snow tendencies were restored, having been missing since the 2.1 release. This affected the KF, GD and SAS schemes that have cloud-ice/snow detrainment.

The Goddard shortwave scheme was improved to prevent occasional blow-ups, and on the Known Problems page, a fix for the YSU PBL was also posted to prevent rare blow-ups. These fixes have little effect other than improving

robustness. The GD cumulus scheme will also have a new robustness fix in 2.2.

In 2.1.2, an update of *real* was made to allow it to handle multiple domains at once, making setting up nested runs much easier.

A tropical channel model was used for regional climate studies, whereby the domain wraps around the tropics and is periodic in that direction, requiring only the north and south boundary conditions. This has been available in WRF since 2.1.1, and can be activated by setting *periodic_x* in addition to *specified* boundary condition logicals. Note that the new SI can set such a domain up, but the current SI cannot. The MM5 pre-processors and converter can also be used.

3. VERSION 2.2

Several new features will be available in Version 2.2.

Four-dimensional data assimilation by grid-nudging is being completed at Penn State (Stauffer et al., 2005 workshop), and is planned for release in the summer.

Observational-nudging is being developed by NCAR/RAL, and there are also plans to release this soon (Liu et al. 2006)

An urban canopy model is being added as an option in the Noah LSM. Tewari et al. (2006) describe this in the workshop.

The CAM3 radiation package has been used in NCAR's regional climate studies this year, and will be made available in the next release. This includes accurate, and sophisticated shortwave and longwave schemes that also can handle a variety of aerosols for atmospheric chemistry applications.

A fully revised and rewritten microphysics package will be introduced (Thompson et al. 2006).

A sixth-order filter (Knievel and Bryan, NCAR) is being added as an option to selectively remove grid-scale noise.

The upper absorbing layer sponge will be stable in real-data cases as of this release by preventing its overlap with the lateral relaxation zone.

The NCEP physics suite is updated to the pre-implementation operational version that is planned for use in the NAM. Among these changes, the Betts-Miller-Janjic cumulus scheme is made more active again, more similar to the 2.0 version. The Ferrier microphysics has been adapted to work better with radiation for ARW, which previously did not distinguish the cloud and precipitation species from the Ferrier total condensate. This will mostly reduce the shortwave blocking effect of clouds with that scheme.

The Dudhia shortwave scheme has a new parameter (*swrad_scat*) to allow tuning of the clear-sky scattering effect that can account for aerosols to some extent.

4. PLANS

There are many ongoing projects involving new physics options that may feed back to the community model in the near future. Some presented at this workshop include a bin microphysics package (Lynn et al. 2006), and CSU microphysics (Fowler and Vonder Haar, 2006). At least two more radiation schemes may be added in the coming year. There are also WRF physics development efforts at NASA-Goddard, NOAA, EPA, NRL and Yonsei University, Korea, among others, that may feed into the community model in

the future. The Community Land Model (CLM) from CCSM is being coupled to WRF as part of an ongoing regional climate physics effort at NCAR.

Additionally, as grid sizes reduce, interest grows in improving large-eddy modeling capabilities, and some work at NCAR (C.-H. Moeng) has shown success in nesting at these scales using WRF's sub-grid parameterization. Further work is needed to test the behavior in complex topography, and to couple this physics to the land-surface model and the atmospheric physics before 3d TKE sub-grid diffusion schemes can replace PBL schemes in fine-scale real-data simulations with grid sizes near 100 m.

Further plans in the dynamics relate to developing an initial global WRF capability using code developed at Cal Tech (A. Toigo, M. Richardson) that can define a lat/long grid with filtering in polar regions. Another area of development is a more generalized vertical coordinate from G. Zängl (U. Munich). Also a positive definite advection scheme from W. Skamarock will help with scalar conservation and transports.

5. ACKNOWLEDGMENTS

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6. REFERENCES

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